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Snavely King Misstatement	Actual Andersen Paper Statement
8. Notably, Andersen never addresses the specific statutory requirements identified in paragraph 6 of the Accounting NPRM, nor does it consider the need of State commissions for consistent regulatory reporting. (p. 7)	As discussed in Section IV of the Andersen Supplement, the recommendations contained in the Andersen Paper do not compromise the Commissions' ability to fulfill their statutory obligations with respect to audit, monitoring or enforcement of the regulatory accounting process.
9. Detailed historical cost data provides the foundation for every reliable service cost study. Without the benefit of detailed historical cost data, such studies cannot be properly prepared or evaluated (p. 8)	What Snavely never does is address the fact that Class B historical accounting information, or even GAAP-based financial results, would also provide a more than adequate basis for the preparation of service cost studies.
10. The Telecommunications Act of 1996 has increased, not decreased, the requirement for detailed cost data ... (p. 8)	This statement is nowhere to be found in the Telecommunications Act and is contrary to its mandate to provide for a deregulatory framework.
11. As will be discussed throughout this report, the Commission's current rules strike an appropriate balance between the interests of investors and those of ratepayers. (p. 10)	This statement is contradicted several times within the Snavely King Report itself. Refer to Snavely misstatements #4 and #5.
12. Andersen's criticisms ignore the primary purpose of Part 32. (p. 11)	See Snavely misstatement #4. See also Section 32.1 of the USOA, which states that the revised USOA will allow reporting of results to be used by regulators, management and the financial community.
13. Since external financial reports are derived from the Part 32 accounting, the USOA is obviously useful for external reporting. (p. 13)	See discussion in Section V of the Andersen Supplement. This could be said about any chart of accounts, no matter what its relevance is to the company's operations, its industry, or its peer group.

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14. Similarly, Andersen states that "the LECs believe that removing Part 32 completely would not necessarily result in fewer accounts, because many of those accounts would still be necessary for management purposes." It is hard to reconcile this statement with Andersen's contention that the Coalition LECs "are not able to use Part 32 to capture useful management information." (p. 13)	Snavely King apparently did not read the very next sentence in the Andersen Paper which states, "However, the focus could be shifted towards providing meaningful management information within a simplified (Class B) chart of accounts structure." (p. 21)
15. Since most of its survey companies are assumedly non-regulated, this difference might generally be viewed as a cost of regulation. As such, it represents a real bargain. (p. 14)	Actually, approximately one-half of the studied companies were regulated entities and not solely in the telecommunications industry.
16. It is interesting to note that the USOA for these [electric utilities] companies, as prescribed by the Federal Power Act (18 CFR 101), contains far more accounts (396) than the USOA for telephone companies (261). (p. 14, footnote 25)	What Snavely doesn't say is that the FERC USOA contains separate accounts for the major power generation segments - including nuclear, coal, hydro and steam generation, etc. Eliminating this repetition, the FERC chart of accounts only has marginally more accounts. After taking into consideration the expense matrix, an extra dimension of detail required by the FCC USOA (virtually increasing the number of expense accounts by a factor of four), the FCC requires more detailed information to be maintained in the chart of accounts than does the FERC.
17. A move to Class B accounting would deprive the Commission of data needed to make meaningful cost allocations pursuant to its Part 64 Rules for the separation of regulated and non-regulated costs. (p. 15)	This is an inaccurate statement - see Sections IV and VI of the Andersen Supplement. The Part 64 Rules apply today to ILECs subject to the Class B accounting rules.
18. Ironically, Andersen itself notes that activity-based cost information (e.g. salaries and wages) is often a focus of management information systems used to present a clear picture of activities performed to produce a product or service. (p. 17)	Yes, but not on an account-by-account basis. The focus of most charts of accounts is on the production of meaningful management information that rolls up to produce financial information in accordance with GAAP.

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19. Andersen's reference to ILEC competitors is irrelevant. (p. 18)	The Commission's responsibilities under the Telecommunications Act include the advancement of competition in all markets. The availability of comparable financial data would allow the FCC and State Commissions to benchmark performance and assess the reasonableness of interconnection, resale and resultant end user customer rates.
20. As discussed above, GAAP protects the interests of investors, not ratepayers. The SEC's responsibilities are similarly focused, as are those of independent auditors, such as Arthur Andersen. (p. 19)	See discussion of GAAP in Section VI of the Andersen Supplement, where it is described how both shareholders and ratepayers are protected with the effective application of GAAP.
21. Andersen is highly critical of the depreciation rates prescribed by the Commission. Andersen's criticisms are way out of date. (p. 22)	See Section VI of the Andersen Supplement for a complete discussion of depreciation issues, including the history and use of the USOA accounting rules and the correct comparison of depreciation reserve levels and deficiencies.
22. If the Commission were prescribing depreciation rates based upon historical indicators, it would be prescribing depreciation rates in the range of 3 to 5 percent. This rise in reserve levels has largely eliminated reserve deficiencies for the large ILECs. In summary, Andersen's criticism of the depreciation rates currently prescribed by the Commission is unfounded. (p. 25)	See Section VI and Attachment 4 of the Andersen Supplement which shows depreciation reserve deficiencies totaling approximately $34 Billion, which demonstrates a continuing significant problem for the ILECs.
23. Given their incentive to keep regulated earnings low, and the conservative bias of GAAP, it is likely that the ILECs would find it appropriate to raise their depreciation rates to levels which would best protect investor interests. In essence, they would be prematurely freed from economic regulation. (p. 26)	See Section VI of the Andersen Supplement. Should regulatory and financial reporting be consistent, then the "objective" of keeping regulatory earnings low would be directly mitigated by the "objective" of reporting earnings that meet or exceed analyst and investor expectations.

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Snavely King Misstatement	Actual Andersen Paper Statement
24. In summary, Andersen's recommendation on depreciation would threaten not only the maintenance of just and reasonable rates, it would also adversely affect the Commission's competition and universal service initiatives. (p. 26)	Snavely King ignores the GAAP objectives of financial reporting which call for the depreciation of assets over their "economic" lives as discussed on pages 30 and 35-36 of the Andersen Paper.
25. Andersen recommends that the ILECs be given free reign to consolidate plant accounts and roll-up Continuing Property Records ("CPRs") into higher-level retirement units. (p. 27)	Obviously, management would need to maintain sufficiently detailed plant accounts and underlying property records in order to effectively manage company assets and comply with GAAP requirements as discussed on pages 33-34 of the Andersen Paper.
26. The establishment of inordinately high expense limits, for example, would increase the expenses reported by an ILEC in a given period. Since this would tend to understate reported income, rather than overstate it, it would be considered a "conservative" practice under GAAP. (p. 30)	Expense limits are a materiality-based accounting convention to be used only when the costs exceed the benefits of applying GAAP. Setting of "inordinately high expense limits" would not be allowed under GAAP if financial results are materially impacted.
27. The ILEC alone determines which assets will be placed on the books of each of its organizational entities, and which services will be provided to other entities. (p. 33)	This statement implies that separate subsidiaries, including the ILEC's corporate holding company, have no say in asset purchase, resource allocation and service/ product decisions. This is, of course, untrue.
28. While the 50% [prevailing price] requirement may be somewhat arbitrary, it represents a reasonable balance between the interests of investors and those of ratepayers. (p. 34)	What benefits do investors realize from this requirement? In reality, investors and ratepayers both lose in this area due to the increased costs incurred by the ILECs to comply with this detailed requirement.
29. Andersen's recommendation that the Commission place full reliance on GAAP ignores the fact that GAAP protects investors and not necessarily ratepayers. (p. 37)	See Section VI of the Andersen Supplement for a discussion of GAAP and its objectives, where it is shown that the attributes of GAAP, collectively, serve to protect all users – shareholders, regulators, ratepayers, financial analysts and creditors, among others.

Attachment 3

ARTHUR ANDERSEN LLP
ACCOUNTING SIMPLIFICATION IN THE TELECOMMUNCATINS INDUSTRY

SUMMARY OF SFAS NO. 71 DISCONTINUANCE WRITE-OFFS

(Dollars in Billions)

Company	Effective Date	Write-off Amount Pre-tax	Write-off Amount After-tax	Depreciation Reserve Ratio Before	Depreciation Reserve Ratio After
U S WEST	3Q93	$5.1	$ 3.2	35%	57%
Bell Atlantic	3Q94	3.7	2.2	38%	52%
Ameritech	4Q94	3.9	2.3	43%	55%
BellSouth	2Q95	4.4	2.7	44%	55%
NYNEX	2Q95	4.6	2.9	44%	53%
SBC Communications	3Q95	4.6	2.8	44%	61%
Pacific Bell	3Q95	5.7	3.3	41%	58%
Frontier	3Q95	0.2	0.1	48%	60%
GTE	4Q95	7.4	4.7	43%	61%
Sprint	4Q95	1.0	0.6	47%	55%
SNET	4Q95	1.2	0.7	41%	71%
		$41.8	$25.5		

Source: Annual Reports on Form 10-K filed with the Securities and Exchange Commission.

Attachment 4

Arthur Andersen LLP
Accounting Simplification in the Telecommunications Industry

Regional Bell Operating Companies and GTE Telephone Operating Companies
Summary of Depreciation Reserve Deficiencies at December 31, 1997

(Dollars in Millions)

Company	Depreciable Plant	FCC Part 32 Basis Depreciation Reserve	FCC Part 32 Basis Percent	SEC External Reporting Basis Depreciation Reserve	SEC External Reporting Basis Percent	Reserve Deficiency Amount	Reserve Deficiency Percent
	(a)	(b)	(c) = (b) / (a)	(d)	(e) = (d) / (a)	(f) = (d) - (b)	(g) = (f) / (a)
Ameritech:							
Illinois Bell	$9,472.5	$4,547.9	48.0%	$5,588.9	59.0%	$1,041.0	11.0%
Indiana Bell	3,281.7	1,750.8	53.4%	2,111.1	64.3%	360.3	11.0%
Michigan Bell	8,294.0	4,422.7	53.3%	5,425.9	65.4%	1,003.2	12.1%
Ohio Bell	6,213.6	3,174.5	51.1%	3,939.8	63.4%	765.3	12.3%
Wisconsin Bell	3,010.6	1,505.8	50.0%	1,836.7	61.0%	330.9	11.0%
	30,272.4	15,401.7	50.9%	18,902.4	62.4%	3,500.7	11.6%
Bell Atlantic:							
Deleware	779.6	352.3	45.2%	404.2	51.8%	51.9	6.7%
Maryland	5,789.3	2,607.7	45.0%	3,271.8	56.5%	664.1	11.5%
New Jersey	9,561.6	4,478.8	46.8%	5,597.0	58.5%	1,118.2	11.7%
New England	13,114.4	6,555.3	50.0%	7,476.2	57.0%	920.9	7.0%
New York	21,018.0	10,058.3	47.9%	11,967.5	56.9%	1,909.2	9.1%
Pennsylvania	9,626.2	4,555.8	47.3%	5,750.4	59.7%	1,194.6	12.4%
Virginia	5,846.3	2,637.8	45.1%	3,265.8	55.9%	628.0	10.7%
Washington, D.C.	1,626.1	672.1	41.3%	849.6	52.2%	177.5	10.9%
West Virginia	1,718.5	902.5	52.5%	1,032.2	60.1%	129.7	7.5%
	69,080.0	32,820.6	47.5%	39,614.7	57.3%	6,794.1	9.8%
BellSouth Telecommunications	47,706.0	24,147.1	50.6%	29,015.0	60.8%	4,867.9	10.2%
SBC Corporation:							
Southwestern Bell	30,670.0	14,358.6	46.8%	18,460.0	60.2%	4,101.4	13.4%
Pacific Bell	28,886.0	13,404.0	46.4%	17,606.0	60.9%	4,202.0	14.5%
	59,556.0	27,762.6	46.6%	36,066.0	60.6%	8,303.4	13.9%

Arthur Andersen LLP
Accounting Simplification in the Telecommunications Industry

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(Dollars in Millions)

Company	Depreciable Plant	FCC Part 32 Basis Depreciation Reserve	FCC Part 32 Basis Percent	SEC External Reporting Basis Depreciation Reserve	SEC External Reporting Basis Percent	Reserve Deficiency Amount	Reserve Deficiency Percent
	(a)	(b)	(c) = (b) / (a)	(d)	(e) = (d) / (a)	(f) = (d) - (b)	(g) = (f) / (a)
U S WEST Communications	32,572.0	15,116.9	46.4%	19,041.0	58.5%	3,924.1	12.0%
Total RBOCs	239,186.4	115,248.9	48.2%	142,639.1	59.6%	27,390.2	11.5%
GTE Telephone Operations:							
GTE North	9,221.4	4,605.7	49.9%	6,432.4	69.8%	1,826.7	19.8%
GTE California	10,253.3	5,214.7	50.9%	6,278.6	61.2%	1,063.9	10.4%
GTE Florida	4,229.3	1,852.8	43.8%	2,470.5	58.4%	617.7	14.6%
GTE South	3,162.5	1,500.4	47.4%	2,664.0	84.2%	1,163.6	36.8%
GTE Southeast	5,243.8	2,434.1	46.4%	3,317.2	63.3%	883.1	16.8%
GTE Northwest	3,263.1	1,365.6	41.8%	2,127.1	65.2%	761.5	23.3%
GTE Hawaii	1,781.7	738.3	41.4%	1,173.9	65.9%	435.6	24.4%
	37,155.1	17,711.6	47.7%	24,463.7	65.8%	6,752.1	18.2%
Total RBOCs and GTE	$276,341.5	$132,960.5	48.1%	$167,102.8	60.5%	$34,142.3	12.4%

Notes to Schedule:

(1) - Depreciable plant amounts were obtained from Annual Reports filed on Form 10-K as of December 31, 1997.
(2) - Part 32 depreciation reserve amounts were obtained/accumulated from Snavely King Report (Attachment 4).
(3) - GTE Midwest and GTE/Contel of Virginia amounts were excluded from this schedule as Form 10-Ks are not filed for those subsidiaries.

Evaluation of the Effect of a

Change in Depreciation Rates on the FCC's X-Factor

Affidavit of Professor Frank M. Gollop

Boston College

November 20, 1998

This brief report evaluates the effect of a hypothetical change in the prescribed rate of depreciation for capital assets on the X-Factor derived in the FCC model.[1] The structure and assumptions of the Commission's model necessarily infer that changes in allowed depreciation rates affect the measured RBOC TFP and input price differentials but in exactly offsetting amounts, leaving the resulting X-Factors unaffected. The model's economic logic leading to this result is described below and is verified by a simulation run on a replicated and updated form of the FCC model.[2]

A change in the depreciation rate affects measured capital input and its rental price in the FCC model but influences none of the other data accounts. The rate change has no effect on output quantities or revenues or any of the price, quantity, or expense accounts relating to either labor or material inputs. Moreover, there is no effect on total property compensation defined in the FCC model as total revenues less operating expense plus depreciation, a sum unaffected by changes in depreciation expense. However, changes in depreciation rates do impact both measured capital input and its rental price. First, given the Commission's adoption of the perpetual inventory method of capital accumulation, the hypothetical increase in depreciation rates accelerates the depreciation of capital

[1] A full description of the FCC model appears in the Commission's Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262, FCC 97-159, Appendix D, (released May21, 1997).

[2] For a complete description of this updated model, see Attachment D to the Comments of the United States Telephone Association, *In the Matter of Access Charge Reform*, CC Docket No. 96-262, *Price Cap Performance Review for Local Exchange Carriers*, CC Docket No. 94-1, *MCI Telecommunications Corporation Emergency Petition for Prescription of Access Charges*, CC Docket No. 97-250, *Consumer Federation of America Petition for Rulemaking*, RM 9210, filed in response to the FCC's Public Notice, released October 5, 1998, FCC 98-256. The attachment is titled "Technical Report: Replication and Update of the X-Factor Constructed Under FCC Rules(,)" prepared by Frank Gollop dated October 22, 1998.

stock, thereby reducing measured capital input and increasing measured RBOC TFP growth. Second, given that capital's rental price is defined as the ratio of unchanged property compensation to capital input, the resulting percentage change in capital input is mirrored exactly by an offsetting percentage change in its rental price. The resulting increase in the TFP differential is offset exactly by a decrease in the IPD because the percentage changes in capital input and its rental price are identical but opposite in sign and are weighted by the same cost-share weights in their respective TFP and input price terms for the RBOCs. As a result, the X-Factor is left unchanged.

The above reasoning is validated through simulation. At present, the FCC model is calibrated using an authorized depreciation rate for plant and equipment that averages 7.336%. (See Chart D7 in Appendix D of the Commission's May 1997 order.) To examine the effect of a change in this rate, a sensitivity test was run based on an assumed one percentage point increase in this allowed depreciation rate for years 1991 through 1997. The 7.336% rate in the Commission's perpetual inventory calculation for capital stock was replaced for these years with an 8.336% rate. The incremental depreciation dollars based on this one percentage point rate increase in each year 1991-97 were added to depreciation expense in Charts D7 and D8 and to operating expense in Chart D8. As expected, capital input growth in Chart D9 decreased leading to an increase in RBOC TFP growth in Chart D1. Concurrently, increased depreciation expense raised the growth rate of the RBOCs' capital rental price (Chart D9) and therefore reduced the IPD in Chart D1 by an exactly offsetting amount leaving the X-Factor unaffected.

A discussion of the merits of forbearance from depreciation regulation can proceed without regard to the effect of any change in depreciation policy on the X-Factor as measured by the Commission. The structure of the Commission's model ensures that the X-Factor will be unaffected by changes in depreciation expense.

I hereby swear and affirm that the statements contained in the attached affidavit are true and correct to the best of my knowledge and belief.

Frank M. Gollop

November 20, 1998

Review of the
Federal Communications Commission's Staff Report of Audit Findings
Audit of the Continuing Property Records of
BellSouth Telecommunications

Ernst & Young LLP has been retained by BellSouth Telecommunications, Inc. to conduct a statistical review of the above-referenced draft audit report on their behalf. Our goal was to determine if there were significant errors and omissions from a statistical and processing standpoint. This work is subject to the Nondisclosure Commitment dated July 27, 1998. The work at Ernst & Young has been directed by Dr. Fritz Scheuren.

Dr. Scheuren, a mathematical statistician and internationally known sampling expert, is the National Technical Director of Statistical Sampling for Ernst & Young LLP. He has extensive sampling background from many years of government service with the IRS and the Social Security Administration and most recently at Ernst & Young. His role has been (and is here) not to take an advocacy position but to make sure that the statistical methods in obtaining and using the data are appropriate for the task at hand.

With this intent in mind, we have analyzed the methods used by the FCC in the continuing property record audit. We find their methodology lacking in a number of respects. The FCC's results, in consequence, do not necessarily present a fair representation of BellSouth's "missing" investment. We summarize our findings below. Technical notes that explain how we arrived at some of our findings are attached as Appendix A.

Summary

To give focus to our review comments we will quote the language of the draft report's conclusions (page 14 of Appendix B). Conclusion 2 states:

> "Furthermore, from our sample, we estimate by inference, using a confidence interval of 95 percent, that $291.7 million ± $142.9 million of BST's (BellSouth's) hard-wired COE (central office equipment) cannot be found. Thus, as a result of the audit we expect, with 95 percent certainty, that the costs for hard-wired COE recorded in BST's CPR is overstated by an amount between $148.8 million and $434.6 million."

Based on a number of significant mistakes and other biases, we find that the Commission cannot support this extrapolation. There are at least four problems with their audit approach:

> First, the failure to attempt an investigation of whether equipment was present that was not identifiable in the property records precludes a claim that property is "missing." (The inverse of the audit's investigation of whether there were property records for which the corresponding equipment could not be found.)

> Second, the sample design was intended to measure the *proportion of items* not found. It was not intended to measure the *dollar value* of missing items. Had the intent been to make such an inference, the sample should have been designed differently. The audit report's effort to make that jump with the small sample of central office locations actually visited is highly questionable and subject to significant potential sampling error.

Third, the margin of error for missing property investment suggested in the audit report is too narrow. The margin of error was calculated using methods that require a larger sample size than the one used in the audit. When corrected, the margin of error is so wide that the results provide little useful information concerning the dollar value of plant not found. "Actionable" conclusions concerning statements about dollar amounts of investment should not be made from such results.

Fourth, the methods identified in the audit report contain biases which create inaccuracies and further undermine reliance on the results. These biases include both potential biases in the statistical calculation and in the audit methodology.

Below we discuss each of these errors. Their compound effect significantly undermines the validity of any conclusion that attempts to extrapolate the results of this audit to BellSouth's investment base. Our analysis considered this compounding effect as well as the possible impact attributable to BellSouth's own re-scoring.[1]

Additionally, the staff analysts seem to believe that these errors are justifiable since they claim that their results are corroborated by a Bayesian analysis that was applied to the data. No information regarding important aspects of the Bayesian analysis was given in the staff report. Claims concerning how Bayesian methodology eliminates problems in the initial analysis are made without justification. And final results are given without any discussion of how they were derived. Thus, an unsubstantiated Bayesian analysis, using data containing biases, is being used to corroborate the staff's flawed initial analysis. Because the flaws of the original analysis are implicit in their Bayesian model, their new model provides no additional support.

Lack of a Two-way Audit

The FCC audit only investigated in one direction: sampling from the property records to see if a selected line-item can be located where the property record says it is. If the intent of the audit was to attempt a quantification of "missing" equipment, it would be necessary to conduct a two-way audit. A two-way audit would also include an inventory of randomly selected offices and a check to see if items found in the inventory can be tied back to the property records. The only way to determine "missing" equipment would be to take the results of the initial audit and net them against the results of the reverse direction audit. The failure to conduct the reverse audit here means that the FCC quantification of "missing" investment systematically overstates the actual value and cannot be relied on.

Sample Design (Choosing Line-Items for the Audit)

Related to the issue of the goal of the audit, is the sample design – the plan for choosing the way in which records are selected from the CPR database so that fairly precise estimates can be obtained. By this we mean that the sample should be planned so that resulting confidence intervals will not be too wide with respect to the estimate.

The audit report includes two estimates – one based on the proportion of the number of line items that were or were not found to be in conformance with the rules; the other based on the dollar value of investment not located in the audit. In general, one can get reasonable precision for an estimate of

[1] A more appropriate methodology would be the use of lower confidence bounds with a high confidence level – 99 percent. The IRS uses this type of lower bound approach in their audit findings. In fact, the IRS calculates estimates in three ways. The method that produces the smallest margin of error is used, and the 95 percent lower confidence bound is the amount assessed. Due to additional non-sampling error and other biases, it is prudent, in our opinion, to use a 99 percent lower confidence bound for the FCC audit.

proportion (as the audit report sought in the first estimate) using many different sample designs. Estimates of total dollar values (such as sought in the second estimate) are far more complex and difficult. Results may vary widely under different sample designs, so one should take care when designing for these estimates. Thus, an experienced statistician faced with estimating a proportion and a total dollar amount, would usually plan the sample to obtain a relatively precise estimate for the total dollar amount, and accept the precision that is obtained for the proportion estimate.[2]

The methods identified in the audit report did the exact opposite. The audit sampling plan was designed to produce a precise estimate of the proportion, and accept a relatively imprecise estimate of the total dollar amount. Note, that the margins of error given for the proportion estimates are approximately 3 percent (the plus/minus values given in conclusion 1, page 14 of Appendix B of the report.) However, the reported margins of error for the total investment tied to records of items that were not located are approximately 49 percent of the estimated value. These are very imprecise estimates. Thus, even based on the draft report's own calculations without our corrections (and ignoring the failure to conduct a two-way audit), we find the evidence very weak when making statements about total dollar amounts.

Understated Margin of Error Calculations

The FCC audit report also understates the margin of error of their results. The larger the margin of error, the less reliable the results. The formula employed in the draft report assumes that the sample is large enough to apply a standard (normal) distribution approximation (the "bell-shaped' curve from any introductory statistical text) to obtain confidence intervals.[3] This assumption is wrong. The sample size used in the audit is not large enough to use the normal approximation. This leads the audit report to systematically understate the margin of error in their dollar estimates.

For a simple random sample from the CPR, a sample size of 1,152 (the number of items sampled in the audit) is likely to be large enough for the normal approximation to be appropriate. However, the FCC did not use a simple random sample. Instead central office locations were first randomly selected within groupings (or strata) that the audit staff defined, and then records were randomly selected within chosen locations. In statistical parlance, a two-stage, stratified, cluster design was used.

For this type of design, the total sample size is not as important as the number of locations chosen within each stratum. There were 32 locations. Special advanced techniques need to be used for calculating confidence intervals for these more complex designs.

Based on the FCC's estimates and their standard errors, and correcting for the small sample sizes, we conclude that --

> **The estimate for BellSouth's total investment in error, using FCC scoring with partial credit, is $291.5 million. The one-sided 99 percent lower confidence bound[4] is negative $32.6 million.[5] Notice that the lower confidence bound goes beyond zero. This means that**

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[2] One way to have done this is to select many more central office locations, and to stratify the line-items by in-place cost within the selected locations.

[3] For a 95 percent confidence interval this is essentially done by multiplying the standard error (the square root of the variance of the estimator) by 2 and subtracting/adding the result from/to the estimate.

[4] As stated in footnote 1, using a 99 percent confidence bound would more nearly respect the uncertainty of the FCC's results in light of the errors and biases that cannot be quantified.

[5] This uses the published value of the root mean squared error, $72.9 million, and a multiplying factor of 4.447. This factor was found from the results of a simulation described in Appendix A.

there is no statistically significant difference between the estimated total investment not found and zero.

These results assume complete acceptance of the audit report's classification of what equipment in the sample should be deemed missing. The only change from the draft report is that we have corrected the margin of error based on simulation results described in Appendix A.

The draft report also mentions that the true value of understated investment is "most likely" centered around the "best estimate." Confidence intervals give a measure of the precision of the estimate, but no value contained within the interval is necessarily "better" than any other. In a sense, values within an interval are statistically indistinguishable. Thus, a conservative approach, as would be done in an IRS audit, is to use the lower bound of the interval.[6]

Biased Estimates

Statistical biases exist with regard to the methods used to obtain the estimates and the standard error for the estimates (quantities needed to compute the precision of the estimates). The draft report uses an estimation technique that gives a statistically biased estimate, i.e., the average value of the estimator used by the FCC is not the true population total. The actual bias appears to be negligible, but there is a potential problem with the calculation of the mean squared error – it may understate the true value. However, our simulations suggest that the bias in the mean squared error estimate is also negligible.

An alternative approach which avoids some of these problems is to use an unbiased estimate.[7] This method weights each record in the sample inversely to the probability that the record was selected into the sample. The draft report's biased method does not do this.[8] Biased estimates are appropriate in some circumstances, and it may be appropriate for estimating BellSouth's total investment associated with non-locatable line items. We were concerned, nonetheless, because the number of central office locations sampled is small, so we present estimates based on both methods (see Appendix A).

Aside from statistical calculation issues, there are other sources of potential bias. For example, the audit staff did not use the same team of auditors to inspect each location. When examining the proportion of items found by different audit teams, there are noticeable differences in the scoring of line-items. The audit staff tried to correct this control problem by making "back-at-the-office" changes in the scores. It is unclear whether they succeeded in addressing the original team variability in approach since no locations were revisited to verify that the back office scoring correctly represents the true state of the property records.

In addition to the team and re-scoring effects, we are also concerned about statements in the report that refer to substitutions of sampled items. For example, the FCC draft report states on page 7 of Appendix B that

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[6] Op. cit., footnote 1.

[7] The technique that we suggest is given in Cochran, W. G. (1967). *Sampling Techniques*, 3rd ed. Wiley, New York, page 303 (equation 11.21) for the estimate; for the variance of the estimate see page 303 (equation 11.24).

[8] Details for the FCC's biased estimate are given in the Cochran reference, page 303 (equation 11.25). We also note that the equation given as the variance of this estimate is really an approximation for the mean square error, page 305, equation 11.30. The mean square error is the appropriate measure of uncertainty to use for a biased estimate. The Cochran formula is only asymptotically correct. The number of locations is too small for its use in this audit situation without some additional checks on its safety.

"In some instances, the location initially selected was impractical to audit,.... In such cases, another location was randomly selected from that stratum."

If the FCC does not want to audit certain locations, their conclusions should be narrowed accordingly – in fact, just to the records in locations that the FCC was willing to audit. A nice analogy we recently heard is that if you only inventory the shelves in a candy store that you can reach, then you can't make any statements about the candy jars on the shelves that are out of reach.

Bayesian Analysis

The FCC staff performed an additional analysis on the data from the audit sample. The results of this second or "Bayesian" model-based analysis are claimed to be close to the results derived from the earlier "frequentist" or sample design-based analysis. The FCC staff believes that this "closeness" corroborates their findings.

A Bayesian approach relies on a model that, unlike a frequentist approach, employs prior assumptions. Underlying the staff Bayesian arguments is the claim that because the Bayesian approach puts all of their statistical deficiencies into a Bayesian sampling model, the problems with the audit sample and the derived statistics go away. This, however, is not the case. Like any other model, the outputs are only as valid as the inputs and assumptions. The way in which the staff chooses to use Bayesian methodology camouflages the flaws, but does not remove them.

The following table matches three assumptions that the staff claims are true of a Bayesian sampling methodology to the original flaw that they appear to believe can be overlooked.

No.	Assumption about Bayesian Methodology	Frequentist Problem Staff Believes is Resolved
1	An estimate of the population mean is independent of the choice of sample weights or choice of stratification.	Poor Sample Design, Understated Margin of Error
2	The sample mean is the most likely estimate of the population mean.	Determination of Total Cost in Error to be Removed from the Property Base
3	The method is design free, so the estimator is unbiased.	Biased Results

We will address each of these assumptions in turn. The staff does not provide the details of the Bayesian structure that was used for their analysis, that is, the assumptions and formulas used to calculate their results (see Appendix A for a discussion of what is needed). Thus, our comments on the analysis are based on a common approach employed when Bayesian methods are used in survey sampling.

Assumption 1

Bayesian sampling analysis is model oriented. It can, for example, employ a superpopulation from which the finite population – in this case, the CPR database – is a sample. The finite population is physically sampled in order to make inferences.

Several factors make up a Bayesian sampling model, and one of the key factors is to create a probability distribution to incorporate for prior knowledge about characteristics of the population that is being sampled. The staff has not indicated what distribution they are using for their prior knowledge. If it is a

model that assumes a lot of prior knowledge, then justification is needed. A model that assumes little to no prior knowledge generally produces results similar to a frequentist analysis (although interpretation of the results may be different).

While some Bayesian sampling models may provide estimates which do not rely on the sample design, they are often not independent of the choice of design elements such as stratification.[9] With different strata, the Bayesian estimates would usually be different too.

None of this means that the original, frequentist-based analysis was properly done. The sample design is still unsuitable for a precise estimate of the cost associated with unlocatable items, and the margin of error has not been properly calculated. The fact that the staff may have a Bayesian model that provides estimates that are close to improperly calculated values does not provide corroboration.

Assumption 2

In a Bayesian context, the reference to "sample mean" as the most likely value is not clear. We are assuming that the report is referring to the mean of the posterior distribution. While it is true that the Bayesian interpretation of the properties of the estimators is different from a frequentist interpretation, nevertheless, the statement in assumption 2 is not warranted without imposing strong conditions on the prior and the data.

Regardless of what value is "most likely," it is not clear what conclusions, if any, can be drawn from that calculation. In particular, it does not respect the uncertainty in the answer however measured. In our view, the lower bound of a 99% confidence interval remains the best estimate for assessing the total cost of the COE not found.

Assumption 3

The question of statistical bias is technical, and we provide a brief discussion in Appendix A. The elimination of statistical bias in an estimate does not address our main concern of bias induced from nonsampling error. Most of that bias comes from the data collection mechanism. A Bayesian approach is conditioned on the given data collection mechanism; thus, this source of bias still exists and will affect the estimate obtained from the Bayesian model.

Conclusion

The estimates in the draft FCC audit report contain biases and are highly inaccurate in other ways as well. Given these errors and biases, the conclusions in the report concerning the amount of overstated investment are unsound and cannot be fairly relied upon.

[9] See Andrew Gelman, John B. Carlin, Hal S. Stern, and Donald B. Rubin, *Bayesian Data Analysis,* Chapman and Hall, 1998, page 224.

Appendix A
Review of the BellSouth CPR Statistical Audit Plan

This appendix provides further details concerning Ernst & Young's findings in its analysis of the sampling plan used by the FCC for the Current Property Records (CPR) audit of BellSouth. Specifically, there is an in-depth discussion of four issues raised in our summary report on the audit:

- a possibly inappropriate choice of sample design;
- the incorrect calculation of margins of error;
- many sources of bias that affect the estimates; and
- the use of an unsubstantiated Bayesian analysis does to corroborate a flaw frequentist analysis.

A fifth issue, the lack of a two-way audit, was also discussed in the summary report. While we could go into the mathematics of how to produce an estimate of missing property from the results of a two-way audit, we do not feel that it is warranted here. Pointing out the failure to even attempt the necessary two-way audit should be enough.

After discussing each of the above issues, we provide a comparison of calculations we have made with those published in the draft FCC report. To set the tone for these discussions, we first provide some definitions, and describe the notation that will be used in the equations that will follow.

Definitions and Notation

- The population of interest is the central office hardwire records of the current property record (CPR) database of BellSouth as of 7/31/97.

  Denote the total number of such records in this population by M_0.

- We shall refer to a record in the CPR database as a line item.
- A central office location is denoted by the first eight characters of the Common Language Location Indicator (CLLI). We will henceforth refer to each central office location as a CLLI.
- For the audit, CLLIs are divided into L groups or strata.
- A line item belongs to one, and only one CLLI.
- For each $h = 1,\ldots,L$ of the CLLI strata, let

N_h = the number of CLLIs in stratum h,

n_h = the number of CLLIs selected for the audit in a sample from stratum h,

M_h = the total number of line items across all CLLI in stratum h,

M'_h = the total number of line items in all CLLIs selected for the audit within stratum h, and

m_h = the total number of line items selected for the audit in stratum h.

Note that $M_0 = \sum_{h=1}^{L} M_h$.

- Within stratum h (h = 1,...,L), let

  M_{hi} = the number of records in CLLI i (i = 1,...,N_h) of stratum h, and

  36 = the number of FCC sampled line items in the selected CLLI of stratum h.

  Note that $M_h = \sum_{i=1}^{N_h} M_{hi}$,

  $M'_h = \sum_{i=1}^{n_h} M_{hi}$, and

  $m_h = 36 \cdot n_h$.

- Within CLLI i (i = 1,...,N_h when referring to the whole population, or i = 1,...,n_h when referring to the sample of locations for the audit) of stratum h (h = 1,...,L), let

  y_{hij} denote the observed value for line item j (j = 1,...,M_{hi} for the population of line items, but j = 1,...,36 for line items chosen for the audit) within CLLI i of stratum h. For example: if you are interested in the number of compliant line items, then y_{hij} is either 0 or 1 when a line items is either non-compliant or compliant; or if you are interested in the total in-place cost for line items that can't be located, then y_{hij} is the in-place cost of a line item that cannot be located, and zero otherwise.

Sample Design Considerations

A sample design is the plan for choosing items for a sample. According to the draft report, the CPR hardwire audit conducted by the FCC used a two-stage, stratified cluster design. This was accomplished via the following steps:

1. The total number of hardwire line items for the audit sample was determined to be 1082.
    - The methodology for determining this assumed a simple random sample would be taken at both stages.
    - The criteria for determining the sample size was a desire to have a margin of error for the proportion of compliant line items of at most 0.025.
    - It appears to have been implicitly assumed that the degrees of freedom of the estimator would be large enough to use normal distribution theory.
2. It was determined that auditors would try to find the property corresponding to 36 randomly chosen line items within each of a randomly selected central office locations.
3. The number of central office locations needed for the audit was determined to be 30, the result of dividing 1082 by 36 and truncating to an integer.
4. The sampling frame was determine as follows.[1]
    - All line items were clustered within locations that were determined by eight character CLLI codes.
    - After removing non-hardwire records, line item counts were done for each CLLI.
    - CLLIs with less than 100 line items were discarded and the remaining CLLIs were considered to be central offices.
5. The CLLIs in the frame were divided into 11 strata based on the number of line items.
6. The sample size of 30 CLLIs was allocated across the strata proportionately to the total number of records in each stratum.[2] After adjusting the resulting number to be integers that added up to thirty, any stratum that was allocated less than two CLLI selections had its allocation increased to two.[3] This increased the total number of CLLIs in the sample to 31. Additional adjustments increased the total of CLLIs to 32.[4] In turn, this increased the total number of line item for the audit to 32·36 = 1,152.
7. Within each stratum, CLLIs were randomly selected according to the allocation plan in step 6.

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[1] This is not described in the draft report. This procedure was described by the FCC staff to BellSouth, and subsequently relayed to us.

[2] The draft report states that Neyman allocation was used. It does not state what was used as each stratum's variance, S^2_h. We suspect that the variance of the proportion of all compliant line items in the stratum was used with the proportion set at 0.5. If so, the variances are treated as being the same across all strata, and the allocation becomes proportionate to record counts. Our own calculations using proportionate record counts allocation produce results which are consistent with those published in the summary table on page 7 of the draft report's Appendix B.

[3] The draft report is confusing on this issue. It states that three more CLLIs were added based on advice from Census Bureau statisticians. This makes no sense since 30 CLLIs was the target number and 32 was the end result. Since the draft report states that 31 CLLIs were selected, it is probably the case that one CLLI was added to get the total number within CLLI up to two.

[4] After the sample of CLLIs was chosen, a check was done to see if there was at least one CLLI from each of the states in BellSouth's territory. North Carolina did not have a CLLI chosen, so a CLLI from North Carolina was added.

8. For each CLLI selected in step 7, thirty-six line items were randomly selected for the audit.[5]

While this sample design can be used to calculate estimates of many different population quantities, most estimates produced from it will not have very good precision. Major decisions for the design were based on the desire for a precise estimate of the proportion of compliant records. These included:

- determining the total number of line items for the audit;
- allocation of the total number of CLLIs across strata; and to some extent,
- the division of CLLIs into strata.

Even at that, the sample design does not produce the desired effect – a margin of error of at most 0.25 for the estimate of the proportion of compliant line items. This is due to the fact that the effect of clustering – sampling line items within a CLLI – was not taken into account at the design stage. Instead, methods based on simple random sampling were used – even though the design is more complex than a simple random sample. For an account of how to design a complex sample so that a planned precision can be approximately achieved, see Chapter 8 of Kish.[6]

Furthermore, if a precise estimate of the total in-place cost associated with non-locatable line items is desired, then the sample design should take this into account. Selecting CLLIs proportional to the total in-place cost of each CLLI, and stratification based on in-place cost are two concepts that may help reduce the variance of in-place cost related estimators. For more on audit sampling issues, see "Statistical Models and Analysis in Auditing."[7]

As a general rule, the precision of dollar value estimators is much more sensitive to design decisions than are proportion estimators. By this we mean that a design made for a precise dollar estimator will most likely produce a proportion estimate with acceptable precision. The reverse of this is seldom true. Additionally, more CLLIs need to be selected in order to use normal approximation theory. This issue will be discussed more fully in the next section.

Finally, there is mention in the draft FCC report that after the sample of CLLIs was chosen, a check was made to see that all the states in which BellSouth operates had a CLLI in the sample. North Carolina had no CLLI in the sample, so a location from North Carolina was randomly selected. This practice makes the probability of selection for the North Carolina CLLI different

[5] From footnote 18 of the draft report's Appendix B, we know that when the audit team arrived at the central office location, if it was determined that the property associated with a line item was "too hard-to-get-to," another line item was substituted. This line item was the one that preceded the randomly selected item in the CPR listing. This has the potential to introduce bias into estimates.

[6] Kish, L. (1965). *Survey Sampling*. John Wiley & Sons, New York.

[7] Panel on Nonstandard Mixtures of Distributions (1989). Statistical Models and Analysis in Auditing. *Statistical Science*, **4**, No. 1, pp. 2-33.